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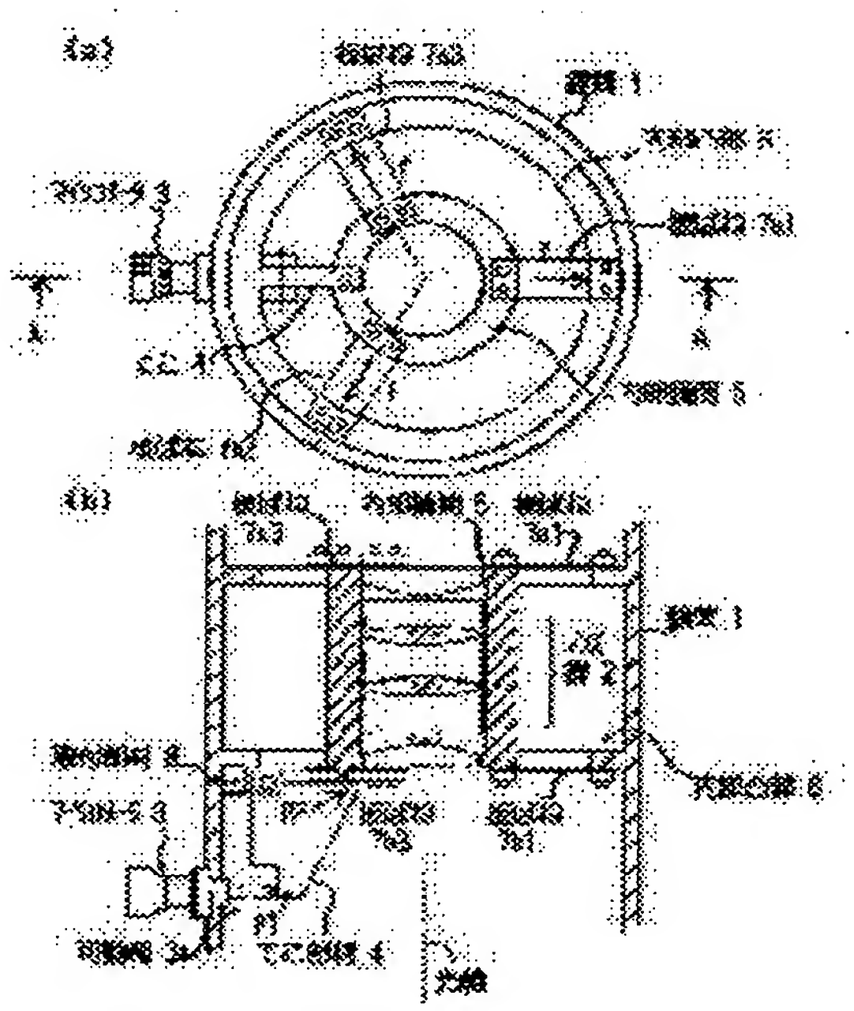
(54) PARALLEL AND STRAIGHT FINE ADJUSTMENT DEVICE AND FINE MOVING DEVICE OF LENS BARREL USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a parallel and straight fine adjustment device which is excellent in parallelism and straightness with respect to movement, whose structure is simple and which is produced at low cost.
SOLUTION: An internal lens barrel 5 is connected to the ends of three pairs of parallel springs 7a1-7b1, 7a2-(7b2), 7a3-7b3 having the same shape and made of the same material, and a lens barrel 1 is connected to the other ends of three pairs of parallel springs. Then, the parallel springs are attached in a state where they have no deflection, and arranged on a plane perpendicular to the optical axis of the lens of the lens barrel 5 so that synthetic force obtained by synthesizing force generated respectively in the parallel springs when the lens barrel 5 is moved may be zero. When the bottom part of the lens barrel 5 is pressed by a lever member 4 by operating a micrometer 3, the lens barrel 5 rises. However, at such a time, the same tensile force is exerted on the respective parallel springs and the synthetic force thereof becomes zero, then the lens barrel 5 is moved straight and in parallel with the optical axis.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The migration member to which the end of 3 or more sets of parallel springs which consist of the same construction material in the same configuration, and the 3 or more above-mentioned sets of each parallel springs was connected, It consists of holddown members to which the other end of the 3 or more above-mentioned sets of each parallel springs was connected, and each above-mentioned parallel spring is attached in the condition that there is no deflection respectively. Each parallel spring Parallel and truth direct fine adjustment which is on a flat surface vertical to the migration direction of the above-mentioned migration member, and is characterized by being arranged so that the composition-of-forces force respectively produced for the above-mentioned parallel spring may be set to 0, when a migration member moves.
[Claim 2] The above-mentioned parallel spring is parallel and truth direct fine adjustment of claim 1 to which the include angle which the intersection of the medial axis of the direction of bending of each parallel spring is on the migration shaft of the specification of the above-mentioned migration member, and each medial axis makes mutually is characterized by the equal thing.
[Claim 3] The lens-barrel to which the end of 3 or more sets of parallel springs which consist of the same construction material in the same configuration, and the 3 or more above-mentioned sets of parallel springs was connected, The internal lens-barrel to which it has been arranged in the above-mentioned lens-barrel, and the other end of the 3 or more above-mentioned sets of parallel springs was connected, It consists of a lens arranged in the above-mentioned internal lens-barrel, and a driving means which generates the driving force for moving the above-mentioned internal lens-barrel in the direction of an optical axis of the above-mentioned lens. Each above-mentioned parallel spring Minute migration equipment of the lens barrel characterized by being arranged so that the composition-of-forces force respectively produced for the above-mentioned parallel spring may be set to 0, when it was attached between the above-mentioned lens-barrel and the internal lens-barrel in the condition that there is no deflection respectively, and it is on a flat surface vertical to the optical axis of the lens of the above-mentioned internal lens-barrel and an internal lens-barrel moves.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the parallel and truth direct fine adjustment using the spring guide used for optical equipments, such as an exposure machine, various precision finishing machines, various precise measurement machines, etc., and the minute migration equipment of a lens barrel using this.
[0002]
[Description of the Prior Art] In optical equipments, such as an exposure machine, various precision finishing machines, various precise measurement machines, etc., it is required that a lens, a work piece, a workpiece, and a device under test should be positioned with high degree of accuracy. The spring guide is broadly used for the migration device in which such a demand is filled for various ****. Since there is neither sliding nor frictional resistance depended for rolling, a spring guide operates without backlash, and it has the advantage in which fabrication cost does not start, with simple structure the top where a maintenance is easy while precision and repeatability are dramatically good.
[0003] As a migration device using the above spring guides, the following are known from the former.
** The migration device using a parallel spring (the 1)
Drawing 5 is drawing showing an example of a migration device which used the parallel spring, 10 is a pedestal, 11 is a mobile and the mobile 11 is attached by the parallel flat spring b1 and b2 of two sheets fixed to the pedestal 10. In this drawing, if a mobile 11 is moved in the direction of the said drawing arrow head, flat spring b1 and b2 will bend, as shown in this drawing B from the condition shown in this drawing A, and a mobile 11 will move it to parallel to a pedestal 10.
[0004] Although the above-mentioned migration device can carry out the parallel displacement of the mobile 11 as mentioned above, when a mobile 11 moves caudad, as shown in this drawing, a mobile 11 moves only deltaL to a pedestal 10 side. That is, the above-mentioned migration device cannot obtain true direct-acting, even if common action is obtained, but the lateral displacement (deltaL) proportional to the square occurs to the displacement I of a mobile 11. For this reason, the above-mentioned device is not suitable as a guide for highly precise parallel and truth direct migration.
[0005] ** The migration device using a parallel spring (the 2)
The device shown in drawing 6 using the flat spring of four sheets of the shape of isomorphism and this construction material as a migration device which can cancel the lateral displacement of the above-mentioned mobile 11 is known. In this drawing, the end of the parallel flat spring b1 and b3 of two sheets is fixed to a pedestal 10, and it is attached in the other end of flat spring b1 and b3 at the medium mobile 12. Furthermore, the end of the parallel flat spring b2 and b4 of two sheets is fixed to the medium mobile 12, and the other end is attached in the mobile 11.
[0006] In this drawing, if a mobile 11 is moved in the direction of an arrow head of this drawing, the parallel springs b2 and b4 bend, and it is going to do deltaL migration of a mobile 11 leftward [of this drawing]. On the other hand, also as for the flat spring b1 and b3 prepared between the medium mobile 12 and the pedestal 10, only tales doses bend, and only deltaL tends to move the

medium mobile 12 rightward [of this drawing]. After all, migration of the above-mentioned longitudinal direction is offset and a mobile 11 moves to a pedestal 10 theoretically at parallel. Although parallel and truth direct-acting are materialized theoretically and a successive range can be made large if it is this device, actually, according to the force by the oscillation which joins a mobile, it pulls other than natural bending to flat spring b1-b4, and force, such as compression, dip, and torsion, is added, and flat spring b1-b4 bends intricately, and does not necessarily carry out the parallel and truth direct-acting of the mobile 11.

[0007] ** The approach shown in drawing 7 is learned as an approach of realizing accurate parallel and truth direct-acting, without using the parallel spring using one pair of flat spring which carried out the migration device above. As shown in this drawing, it fixes to the flat spring base material 13 in which the flat spring b1 and b2 of a couple was able to be attached in the both sides of a mobile 11, and the other end of installation and this flat spring b1 and b2 was attached by the pedestal 10. And drivers, such as a wedge, are prepared in at least three between a mobile 11 and a pedestal 10, and driving force is given in the direction of the said drawing arrow head to a mobile 11. By the above-mentioned device, if each driving force of the driver prepared in three places is made vertically and equal to a mobile flat surface, the parallel and truth direct-acting of the mobile 11 can be carried out.

[0008] In the above-mentioned equipment, if the flat spring b1 in case the flat spring b1 and b2 of two sheets is in 1 flat surface, and the hauling force of the b2 interior are set to 0, by migration of a mobile 11, flat spring b1 and b2 will be slightly pulled to elongation and the interior, and the force will produce it. It is necessary from such equipment to constitute so that a mobile 11 may move within the elastic limit of flat spring b1 and b2. When each driving force of the above-mentioned configuration, then the driver prepared in the three above-mentioned places although it was highly precise and parallel and truth direct-acting of a mobile 11 could be realized must be made vertically and equal to a mobile flat surface and a wedge etc. realizes this, high process tolerance and assembly precision are required.

[0009]

[Problem(s) to be Solved by the Invention] As mentioned above, although the migration device of the above-mentioned ** can move a mobile to parallel, it cannot obtain true direct-acting, and although parallel and true direct-acting are theoretically possible for the migration device of **, since flat spring bends intricately, it cannot necessarily obtain parallel and truth direct-acting according to the force by the oscillation which joins a mobile actually. Furthermore, although parallel and truth direct-acting can be obtained in a comparatively high precision if the migration device of the above-mentioned ** is used, the drive which drives a mobile becomes complicated and there is a problem that a high precision is required of processing and an assembly.

[0010] This invention is made in consideration of the trouble of the above-mentioned conventional technique, to migration, the 1st object has parallelism and a good straightness, and does not have backlash, and repeatability is good and is offering the parallel and truth direct fine adjustment which structure's can be easy and can be manufactured cheaply further. The 2nd object of this invention is offering the minute migration equipment of the lens barrel which parallel and a straightness are good, and there is no backlash, and repeatability's can make often move slightly, and structure's can be easy and can manufacture a lens (or lens group) cheaply.

[0011]

[Means for Solving the Problem] The above-mentioned technical problem is solved as follows in this invention.

(1) The migration member to which the end of 3 or more sets of parallel springs which consist of the same construction material in the same configuration, and the 3 or more above-mentioned sets of each parallel springs was connected, Parallel and truth direct fine adjustment are constituted from a holddown member to which the other end of the 3 or more above-mentioned sets of each parallel springs was connected. It is in the condition that there is no deflection respectively, on a flat surface vertical to the migration direction of installation and the above-mentioned migration member between the above-mentioned migration member and a holddown member, and when a migration member moves, each above-mentioned parallel spring is arranged so that the composition-of-forces force respectively produced for the above-mentioned parallel

spring may be set to 0.
(2) the include angle at which the intersection of the medial axis of the direction of bending of each parallel spring is on the migration shaft of the specification of the above-mentioned migration member, and each medial axis makes the above-mentioned parallel spring of each other in the above (1) -- ** -- arrange like.
[0012] (3) The lens-barrel to which the end of 3 or more sets of parallel springs which consist of the same construction material in the same configuration, and the 3 or more above-mentioned sets of parallel springs was connected, The internal lens-barrel to which it has been arranged in the above-mentioned lens-barrel, and the other end of the 3 or more above-mentioned sets of parallel springs was connected, The minute migration equipment of a lens barrel is constituted from a lens arranged in the above-mentioned internal lens-barrel, and a driving means which generates the driving force for moving the above-mentioned internal lens-barrel in the direction of an optical axis of the above-mentioned lens. It is in the condition that there is no deflection respectively, on a flat surface vertical to the optical axis of the lens of installation and the above-mentioned internal lens-barrel between the above-mentioned lens-barrel and an internal lens-barrel, and when an internal lens-barrel moves, each above-mentioned parallel spring is arranged so that the composition-of-forces force respectively produced for the above-mentioned parallel spring may be set to 0.
[0013] In invention of claims 1 and 2 of this invention, since it constituted as shown in the above (1) and (2), when moving a migration member, the same hauling force can join each parallel spring, the synthetic force can be set to 0, and parallel and true direct-acting of the mobile can be carried out. In invention of claim 3 of this invention, since it constituted like the above (3), when moving an internal lens-barrel by the driving means, like the above, the same hauling force can join each parallel spring, the synthetic force can be set to 0, and true direct-acting of the internal lens-barrel can be carried out in parallel with an optical axis.
[0014]
[Embodiment of the Invention] Drawing 1 is drawing showing the example which applied this invention to the minute migration equipment of the lens barrel used for the projection aligner for semi-conductor manufacture etc., and this drawing (a) is a sectional view of the direction [in / in a top view and this drawing (b) / (a)] of A. In this drawing, 1 is a lens-barrel, 5 is an internal lens-barrel, the lens group 2 is attached in the interior of the internal lens-barrel 5, and for example, a projection scale factor etc. is adjusted by moving the internal lens-barrel 5 in the vertical direction of this drawing (b) minutely to a lens-barrel 1. Six sheets are fixed between the internal heights 6 of the internal lens-barrel 5 and a lens-barrel 1, and the flat spring seven a1 to 7a3 of the same configuration and the same construction material and seven b1 to 7b3 constitute the parallel spring from flat spring seven a1, seven b1 and flat spring seven a2, seven b2 and flat spring seven a3, and seven b3. These parallel springs seven a1, seven b1, seven a2, seven b2, seven a3, and seven b3 are arranged so that the medial axis of each direction of bending may become the surroundings of the optical axis of the lens group 2 at equal intervals (in this case, 120 degrees).
[0015] 3 is a micrometer, 4 is a lever member, and the lever member 4 is supported to revolve by the attaching member 8, and rotates the shaft as a core. Moreover, four lever member [P1] touched moving-part 3a of a micrometer 3, and P2 point is in contact with the pars basilaris ossis occipitalis of the internal lens-barrel 5. For this reason, if a micrometer 3 is rotated in the direction in which moving-part 3a projects, four lever member [P1] is pushed, the lever member 4 rotates, and four lever members [P2] will push the pars basilaris ossis occipitalis of the internal lens-barrel 5, and will push up the internal lens-barrel 5. Although only deltaL tends to move the internal lens-barrel 5 to a lens-barrel 1 side here as shown in said drawing 5 if the internal lens-barrel 5 is pushed up up when only seven b1 is connected with the parallel spring seven a1 between the lens-barrel 1 and the internal lens-barrel 5 Since the parallel spring seven a2, seven b2 and seven a3, and seven b3 are actually prepared between the lens-barrel 1 and the internal lens-barrel 5, the internal lens-barrel 5 cannot perform the above migration, but the force f shown in each parallel spring seven a1 to 7b3 at drawing 1 (a) commits it.
[0016] Each parallel spring seven a1, seven b1 and seven a2, seven b2, seven a3, and seven b3

consist of flat spring of the same configuration and the same construction material, and since it is arranged at equal intervals (120-degree spacing) that it seems that each parallel spring is shown in drawing 1 (a), the synthetic force maintains a balance. That is, when the force produced in each parallel spring seven a1, seven b1 and seven a2, seven b2, seven a3, and seven b3 is regarded as a vector, the compound vector is set to 0 and balances. And tension equal to each parallel spring is added, and true direct-acting of elongation and the internal lens-barrel 5 is slightly carried out to parallel to an optical axis.

[0017] In addition, when an optical axis is the gravity direction, the external force which joins the internal lens-barrel 5 requires the moment with the location of the self-weight of the internal lens-barrel 5 on an optical axis, and the driving point to the internal lens-barrel 5, and requires for the parallel spring seven a1 to 7b3 the force which various bending compounded. However, since each flat spring of each parallel spring is on 1 flat surface, respectively and another side will be opposed by the shrunken force if it is going to extend one side, the parallelism of the internal lens-barrel 5 does not collapse. Moreover, even if it can twist for one parallel spring and the force is added, it supports with other parallel springs.

[0018] In order to investigate the straightness in the minute migration equipment of the above-mentioned configuration, the straightness of the interior lens-barrel 5 of an assembly was investigated for the equipment of drawing 1 using the parallel spring shown in drawing 2 . In addition, the construction material of the flat spring used for the above-mentioned experiment is 0.3mmt(s), and as are shown in drawing 2 and it is shown in drawing 1 , as for the thickness of SKS-CSPH and flat spring, it has arranged the parallel spring with width of face of 26mm of flat spring, a spacing [of flat spring / of 140mm], and a die length [of the variant part of flat spring] of 40mm at intervals of 120 degrees. In the above-mentioned configuration, when the internal lens-barrel 5 was moved in the direction of an optical axis **0.5mm, the internal lens-barrel 5 moved by 0.5 micrometers or less of straightnesses, and it has checked that a required precision was securable. As mentioned above, in this example, since the parallel spring seven a1 to 7b3 of the same configuration and the same construction material has been arranged at equal intervals between a lens-barrel 1 and the internal lens-barrel 5, true direct-acting of the internal lens-barrel 5 can be carried out to parallel to an optical axis. Moreover, since the parallel spring is used, backlash cannot be produced and the internal lens-barrel 5 can be made to move slightly with sufficient repeatability.

[0019] Although the above-mentioned example showed the case where 3 sets of parallel springs had been arranged at 120-degree spacing, the number of parallel springs and arrangement are not limited to the above-mentioned example, and if 3 or more sets of parallel springs are arranged so that the sum of the vector of the force which works for a parallel spring may be set to 0, they can acquire the same effectiveness. Moreover, although it constituted from an above-mentioned example so that the medial axis of the width of face of the direction of bending of each parallel spring might be turned to an optical axis, the direction where the medial axis of each parallel spring goes does not necessarily need to be an optical axis, and should just be a shaft parallel to the migration direction of a mobile. Drawing 3 and drawing 4 are drawings showing the example of arrangement of others of a parallel spring. Drawing 3 (a) and (b) show the case where 4 sets of parallel springs have been arranged to the symmetry around a specific shaft, and come to show the direction of the vector of the force committed for the parallel spring at that time to this drawing (c) and (d), respectively.

[0020] Moreover, the above-mentioned specific shaft may be plurality, and if the hauling composition-of-forces force of the parallel spring concerning the specific shaft in a mobile constitutes so that it may be set to 0 as a whole, the same effectiveness as the above can be acquired. Namely, what is necessary is just to constitute using 6 sets or 4 sets of parallel springs so that it may be set to 0 as a whole, as those hauling composition-of-forces force shows this drawing (c) and (d) as shown in drawing 4 (a) and (b). In addition, if a parallel spring is made into 3 or more sets as shown in above-mentioned drawing 3 and drawing 4 , the force in which it is equal to deformation as a whole will increase, and rigidity will become higher, as the number of parallel springs is increased. However, since it becomes difficult the increase of a number and to hold [of a parallel spring] the precision if it carries out too much, as for the number of parallel

springs, n= 3 is the optimal on processing and an assembly.
[0021]
[Effect of the Invention] Three or more sets of parallel springs which consist of the same construction material in the same configuration in this invention as explained above, Parallel and truth direct fine adjustment are constituted from a migration member to which the end of the 3 above-mentioned sets of each parallel springs was connected, and a holddown member to which the other end of the 3 or more above-mentioned sets of each parallel springs was connected. Since each above-mentioned parallel spring has been arranged so that the composition-of-forces force which is in the condition that there is no deflection respectively, on a flat surface vertical to the migration direction of installation and the above-mentioned migration member between the above-mentioned migration member and a holddown member, and is respectively produced for the above-mentioned parallel spring when a migration member moves may be set to 0, the following effectiveness can be acquired.
(1) Parallelism is high, there is no backlash and it becomes possible to make a mobile move slightly with sufficient repeatability. Moreover, a straightness is good and can realize rigid high migration.
[0022] (2) Since parallel and true direct-acting of the migration member can be carried out with 3 or more sets of parallel springs, the easy device as a driving means for moving a mobile can be used, and the manufacturing cost of equipment can be reduction-ized, and maintainability can be raised.
(3) By applying the above-mentioned fine adjustment to the fine adjustment of a lens barrel, in accordance with an optical axis, true direct-acting of the lens can be carried out in parallel, and a projection scale factor etc. can be adjusted with a sufficient precision. Moreover, the drive for moving a lens can also use easy devices, such as a lever, can reduction-ize a manufacturing cost, and can raise maintainability.
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[Translation done.]